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THE PSYCHO-GENESIS OF SPACE

DE MORGAN declares in the introduction to his *Budget of Paradoxes* that the sense or nonsense displayed by a paradoxer "will not depend upon what he maintains, but upon whether he has or has not made a sufficient knowledge of what has been done by others, *especially as to the mode of doing it,* a preliminary to inventing knowledge for himself." We may well accept this test of a veteran student of paradoxes to guide us aright in the face of the flood of paradoxes let loose in the name of "relativism" by a hitherto sober physical science. If we take a paradox in De Morgan's sense as "something which is apart from general opinion," then we are indeed confronted by the master paradox of all in the treatment of time as a fourth dimension. There is plenty of warrant for the suspicion that Minkowski, largely responsible for this development, has merely uttered the paradoxes of Zeno over again with the important difference that he believes them, whereas Zeno did not. Zeno employed his paradoxes to show that motion is inconceivable in terms of added states of rest; whereas Minkowski seeks to show that not only motion but the time it involves may be treated as a dimension. It would be difficult to invent a paradox that would so completely contradict the daily experiences of men. Yet, we must remember Copernicus, and with him the lesson that paradoxes may become commonplaces. It is the purpose of this paper to consider the grounds upon which the paradox of Minkowski may look forward to such a happy outcome.

We needed to realize at the outset that the issue is a far more significant one than we ordinarily take paradoxes to be. We shall see that here is a conflict that can be traced back to that uncertain dawn when man first sought for the meaning of his experiences. Throughout the history of philosophy, where the external conflicts recorded by the historian, are seen as internal conflicts in the souls of men, the strife between two opposed conceptions of time are never abated. The *time of the clock* and *time lived* form the central issues in the conflict between mechanism and vitalism in biology, between continuity and relativity in physics, and between intellectualism and humanism in philosophy.

What are these opposed conceptions of time? Consider the wholly opposed nature of time *as lived* and time *as measured* in the simple experience of drinking a cup of tea. If thirsty, we impatiently wait for the lump of sugar to dissolve, and the time it requires *seems* to us far greater than the *actual* time recorded by the placid clock on the wall. When, however, the lump is finally dissolved, the time *seems* to pass quickly with the pleasure of drinking; but the clock is placid as before. Curiously enough, however, when these events are recalled later on, it will appear that the interval during which we waited will seem short and the succeeding interval of drinking will seem long. Hitherto, in deference to the clock, we have considered its time as *real* and our own time as *illusory*. It will be the purpose of this paper to ask if the very reverse is not the truth, namely: that the time lived is *absolute* whereas that of the clock is only *relative*. Second, it will be my aim to show that the paradox of Minkowski has grown out of the error of supposing that relative time, the time of the clock, is the only time there is.

Time as lived, far from resembling the divisions of a scale, cannot be represented by a line or any conceivable arrangement of them. Time as lived does not consist of separate moments in juxtaposition, but is a uniform inter-penetration. The time of the clock is reversible: for the purposes of the laboratory it is immaterial whether the clock runs backwards or forwards; and the fact that it repeats itself after every twenty-four hours is a great convenience. An astronomer, observing the transit of a star, may well turn back the hands of his clock or set his pendulum swinging anew, but the time he has wasted in wrong computations cannot be recovered so easily. Time as lived is irreversible, and in just this does the stinging quality of its reality consist.

In truth, there is no spatial figure that can possibly represent time in its fullness; and we can now see that the above differences are only the consequences of a more deep-seated difference between them. Eventually, the fundamental difference between the two conceptions inheres in the circumstance that in mathematical time it is assumed that creation is impossible whereas in the opposed conception it is assumed that creation is unavoidable. It is because science holds that the events with which it deals do not profit by their experiences that it is able to hold to its doctrine of conservation. The power of science to predict rests in its turn on the doctrine of conservation. In short, prediction in science proceeds by eliminating psychological time with the train of the unforeseen that it drags into all calculation. Mechanics is a mathematical science in which prediction is so perfect that time may be considered as non-existent. We can predict the "future" of a machine because it does not "learn" no matter how frequent its repetitions. Conversely, the very fact that a machine and a machine alone is capable of perfect repetition is because it is in capable of improving by practice. On the other hand, a living organism cannot help but improve by practice, and this is because the past is conserved and to it is added the increased power brought by every new experience. It is clear that we might equally well have considered our own time as *real* and that of the clock as *appearance,* for who knows at first hand but that the rate of physical changes go now slow and now fast, leaving the *real* time within us pleased or impatient as the case may be? It thus appears that the problem is first a problem of definition; and it must be said that not a little of the disputation that the problem has exacted in contemporary speculation is the outgrowth of assigned mixed meanings to the terms involved.

What term is properly applicable to the experience of time as lived? This is the sole problem facing us. I believe we prepare the way for insoluble difficulties if instead of this simple ideal we suppose ourselves gauging the truth or falsity of a view from their harmony, not with our experience, but with some supposed "truth" underlying it. We shall not say that what we are seeking is knowledge that will correspond with "reality" unless by reality we mean no more than our experiences. The objection to the term *reality* is that it viciously conceals assumptions that in the metaphysical thinking of the past has given rise to endless trouble. Idealism has taken the term to refer to a universe of truth supposed to subsist without relation to human knowledge. Thus, they are able to save the possibility of knowledge only by the assumption that this reality is really known, and it forthwith declares that reality to be in the nature of an eternally complete and ideal universe. From this position, aside from the flat contradiction it contains, it will be forever impossible to comprehend the nature of human experience, which now becomes the unknown. Of matter, which is not ideal, and finite events, which are certainly not "complete," absolute idealism can give only two accounts. It may call pyramids *unreal* or "appearances" because they are not *per se* ideas, but if this is taken as it is intended, to mean their non-being it is absurd. Ontologically speaking, "appearances" are just as real as anything we can know, and seem somehow to get themselves talked about much more than the eternal verities that are supposed to expose their ghostly nature. On the other hand, if it is meant that pyramids are less real than their eternally ideal counterparts we insist that the proper terms *actual* or *potential* be employed. Materialism, on the other hand, believing as Flint says that "the seen is more potent than the unseen" only rivals the jargon of idealism by its profitless distinction between a *real* phenomenal universe and an *unreal* or epiphenomenal one. The term *unreal* has here been used to mean at once a dual implication of *non-existence* and *insignificance.*

What idealism and materialism plainly do is to demand that experience conform to preconceived ideas about it. This leaves all discourse the egoistic preoccupation of each man proving his case by denying all negative evidence; and history has shown that in such situations the supposed custodians of truth prefer to convince the heads of others by breaking them. Thought, instead of solving problems misses its function by denying their existence. Conceptions indeed form the substance of knowledge, but it is the business of discourse, not to force experience into conceptions already given but to find such conceptions in proper number, as will represent experience in its true unity or diversity.

I shall now point out how the above considerations will concern us in discussing space and time as forms of experience. It is a mistake to suppose that even were time proved to be "relative" that it therefore becomes unreal in any sense. What relativists must mean when they call time "unreal" is *that time conceived as an absolute* is unreal, i. e., not verified by experience. If time is truly so relative that all its characteristics can be represented by a dimension then it is in every sense as real as any or all of the other three. In fine, the issue is solely to decide whether the experience of time can in all respects be considered relative or whether it has characteristics that demand the opposite category, the *absolute.* We may next inquire into the necessary meanings of these latter terms.

By the term relative we mean to indicate the dependence of the signification of anything by its comparison with something else. In order to have such a comparison at all it must be supposed that the terms of the comparison are alike in kind. In short, their comparison can only be in *quantitative* terms. The term *relative,* then, is of necessity inapplicable to the *qualitative* aspect of experience. It may be said that qualities are surely comparable in terms of their *intensity,* but reflection will show that in every idea of intensity there is hidden at once the notion of real and of implied space: it illegimately conveys two contradictory ideas, the idea of an actual space and the idea of a potential one. Space itself is none other than the field where *relations* are found: this is its actual service to science. It is misleading to say that space is the sum total of all points for points *per se* may be anywhere and actually are nowhere until they are given a locus by a relation. Space is a field of "anyness" rendered concrete by a relation, but science rightly holds that relations when empirically established are more than the "mental constructs" of Kant. The substance of the relation consists of the distance it measures between points. This distance, to be sure, may be construed to mean either the sum total of the unit distances comprising it or the effort that is required to traverse it. In exact science distances are always understood in the first sense, and are expressed by numbers. Thus, there is saved from the meaure taken, only its quantitative aspect—unless we inquire too closely into the inner meaning that numbers have for us. So long, however, as numbers are regarded as symbols of pure quantity, those quantities may be decreased or increased at will so long as these changes take place proportionally, hence the accuracy of maps. As geographers, the difference in size between the map and the area it represents are very nearly negligible—not quite negligible, because however minute the map its various points still have to be traversed and hence it will still consume time, though far less time than it would take to traverse the surface it represents. As mathematicians, however, we reach the apex of all possible achievement in map-making for now distances may be represented by figures and any figure may represent any distance desired. In short, we have sacrificed all quality for the sake of schematism, but the sacrifice is only temporary for the reason that scheme making is not the whole of life. As wayfarers we cannot treat the qualitative aspects of life with such lordly indifference. In practice, we are bound to consider distances in terms of the effort it will require to traverse them. We are now interested, not in the surface of the earth *en toto* but in the particular stations we must reach in our wayfaring. The scale of miles we made as geographers will show the same numbers of miles as we shall find in traveling. The great advantage of the scale is that it will enable us to traverse the space with an amount of fatigue so small that we may fail to see that it is a substitute miniature for the real experience. Thought, therefore, does not save us entirely from the "trial and error method" of lower organisms. With humanity, the trial and error method has been transferred to *thought* instead of action; and in a sense, thought is life in miniature, not a quantitative miniature, but a qualitative one, if the phrase may be permitted. The scale of miles is a qualitative replica of the original because it is stored in the memory, and its only disadvantage is that it is necessary to remember when the time for action arrives that each number shall have gradually restored to it, to the very end of the journey, the full measure of quality taken from it during the computation. This full measure must be returned in a varying proportion of *intension of effort* and of *extension of time*. During the journey we may save effort by sacrificing more time, and time may be saved by the intension of the effort: but a complete reduction of one to the other is inconceivable. What is the role played by time and effort during the period of calculation? We shall see that here there is a transposition of the factors involved, where there is an intension or contraction of time and *an extreme extension of effort*. But here, as before, there can be no complete reduction of the one to the other. *In other words, there can be no complete elimination of effort (and, therefore, of time) out of computations, any more than there can be a complete elimination of space out of action.* So inexorably are both facts of experience that a monistic philosophy could only gain credence by eliminating either the one or the other from experience; and the attempts and failures to do this are equally notorious in the history of thought. It is the business of thought, not to deny the experience of space or time but to show how they can concur in the same experience. What the nature of that concurrence is can already be vaguely seen: it is certainly functional whatever else it may be.

We may next concern ourselves about the necessary meaning of the term *absolute*. If it is not to encroach on the meaning of the word *relative* this term must hold that the signification of a thing depends on itself alone. As Bergson has it, a thing is absolute by being absolutely what it is. It is at once obvious that the term is misapplied when referred to a world of space whose points offer only relations. The most common misuse of the term is to take it to refer to a thing in the aspect of its "wholeness" or "allness." We cannot say that a single atom or the whole universe of them are absolute for this would involve the meaningless comparison of a thing with itself, and comparison belongs to the relative and not to the absolute. The only aspect of our experience to which the term absolute may be legitimately applied is to *time*, for *time alone is undivided and this alone forbids relations.* Our very inability to conceive limits to the largeness of the universe or the smallness of it arises because we take it to be a universe of space, and space by its very definition is infinitely divisible or extensible; hence, infinitely relative. It will be objected that successive intervals of time may be related and compared, but in truth such comparison are always made of time already flown and quantified. When we say that the time now passing is more intense or less intense than heretofore we take advantage of the dual signification of the term *intensity;* and it is necessary to rescue this word from equivocation. It has misled psychological speculation because it implies at once the ideas of quality and quantity. It has thus been illegimately employed as a means of measuring qualitative experiences, a goal that has long been dear, not to Weber and Fechner alone, but to the scientists of all ages too enamoured of mathematics. We quantify a sensation as a measurable intensity because we prefigure its result in action even while experiencing it. There is in every sensation a reflexion of the extensity which it must meet, but to endure in memory they must be purely qualities, and as such, they are not relative. Time in a relative sense has no experiential meaning.

However, time is an absolute in a quite different sense than the word was employed by Newton. In Newtonian physics time is considered an absolute in the sense of a uniform flow. In the literature of modern physical relativism, it is common to refer to the Newtonian conception of time as "the relativism of Newton" to distinguish it from the "relativism of Einstein." The relativism of Newton is supposed to inhere in the inference that since time is uniform in its flow, its actual rate, like the actual extent of distances is negligible. This form of relativism is supposed to be distinct from Einstein's in that the latter considered the flow of time as relative to bodies while Newton considered its flow independent of them. Examination will show that the difference is only a verbal one. Underlying both conceptions is the notion that time is a literal flow, like that of water. Now, it is only a verbal difference whether we say that this flow is relative to bodies, as does Einstein, or that the motion of bodies is relative to the flow of time, as does Newton. If we once say, as does Newtonian physics, that time is absolute, we cannot then say that its *absolute rate* does not matter, for we do so only by smuggling in some other absolute by means of which its rate is determined. Such a conception of time should perhaps be described as "relatively absolute" and would not be one whit different from the time of Einstein which is "absolutely relative." Both of them, De Morgan would surely say, go beyond all serious paradoxing, and belong in the class with "round squares" and "square circles." Clerk Maxwell is the author of that other paradox which holds that should all bodies at the same time receive a blow that would increase their motion by a proportionate amount, the change would go undiscovered. Poincare has invented a similar one in which it is held that should the universe expand and contract uniformly, man would not be able to discover it. In either case, the reason why the changes are not discovered is because they are supposed to occur *instantaneously,* that is, without the change from one state to the other occupying an actual duration. Now, an instantaneous change is as bad a paradox as any. If no time is permitted for the "changes" of which they speak, then indeed, no change has occurred. The seeming paradoxes arise because we imagine ourselves at once to be subject to the change, but that we still carry with us the memories of the previous universe.

Let us apply some of these considerations to the details of the physical conceptions of Newton and Einstein. Both seek an eternally conserved universe, and this is one, as we have seen, that must be unaffected by time. All changes are to be purely quantitative, and the vehicle in which they occur is the ether. Not only this, but ether is intended to solve that other persistent problem of the problem as to how in a timeless universe there can be an exchange of influences between mutually external objects. To illustrate, we will allow *A* and *B* to represent any objects in juxtaposition, two electrons, or, if you please, two stars. How is one to impart its motion to the other? *A* cannot displace *B* until *B* moves, and *B* will not move until *A* moves it. Not only are we left in this deadlock but the whole concept of contact between bodies is hardly imaginable. We can only say negatively that two indivisible atoms are in contact when they are neither separated nor invading. The miracle of transmitting the motion of one to the other occurs on contact, for manifestly that transfer could not occur while they are completely separated. But how are we to conceive the contact to accomplish the transfer? If the contact is a passive one it will not do so. On the other hand, how can a contact be active without involving at once the two contradictory notions of a simultaneous separation and invasion? Such a contact would moreover have to be instantaneous, which, again, leaves it merely passive. But physics has found in the concept of elasticity an escape from the difficulty. The property of elasticity will allow *B* to yield to *A* and we are able to image the rebound of B. But since both *A* and *B* are by hypothesis indivisible, we cannot say that they become distorted for this supposes that they are not indivisible but are themselves compositions of parts into which distortions may enter. The problem of interaction would thus not be solved by the concept of elasticity but only transfers it to other *A's* and *B's* within the first *A* and *B* with which we began. Thus, when we logically follow the simple impacts of objects, constantly witnessed by the eye, we are left in a mystifying quandary. The difficulty we have hit upon is, stating it generally, the difficulty of conceiving how there can be a change of one state to another without an intermediate time evolution. This factor atomism alone cannot provide, so the physics of Newton has invoked ether to supply the defect. We shall now inquire whether the ether theory unties the Gordian knot or only cuts it.

The ether is the medium of exchange when energy is sent from body to body; and during the transmission, serves as the storehouse of potential energy. In other words, it is a substitute for an evolution in time without which a change from one state to another is unthinkable. The theory of ether is therefore at once used by science to embody the contradictory notions of an eternally conserved universe and an eternally evolving one. By this means science is enabled to regard its utterances as not only *useful* but as *true* in the philosophical sense. In short, atomism would be at once the description and the explanation of experience. But we have already seen that a harmony between the idea of the reality of development and the idea of the unreality of time is impossible; and science has managed to secure the appearance of such a synthesis by shifting the incongruity to the concept of the ether. Ether, accordingly, embodies a group of contradictory properties: it is at once matter and non-matter; it exists as do other bodies but offers no resistance; it is imponderable but still transmits energy in the form of waves as real as those of an unquiet sea; it is at once perfectly rigid and perfectly elastic. That Michaelson, Morley, Miller and others should fail to find objective evidence of the existence of such an ether is hardly surprising! The great weakness of Newtonian physics is that it fails to provide an image of how energies are transferred in an eternally conserved universe. But not only has it failed here, but further inquiry will show that its failure is completed by its failure to image the universe as at all eternally conserved.

In Newton's view the universe is infinitely extended and the result is that when we wish to determine the gravitational effects at any point within it we are unable to arrive at a final sum, for these effects will not terminate in a given amount since they are eternally added to from gravitational effects coming from the ever deepening removes of space. The only solution for this difficulty is to suppose that our universe is finite and measurable. But this offers difficulties as great as the last for now we are again without a quantitative universe for its average density will approach zero. The universe will in this view be eventually dissipated by radiation in straight lines into infinite space and would eventually cease to exist, a result far from the doctrine of conservation.

The failure of Newtonian physics offers cues to the relativists for a better solution. To save the situation it is necessary to invent a scheme of things giving us both the properties of space and time without actually admitting the latter as in the nature of a growth or maturation. There is necessary an image of the universe in which it will appear as eternally conserved but still with a history. Now, to have a natural history it is necessary to provide against the possibility of a stable equilibrium. A stable equilibrium, however, is inevitable to a finite universe or to any "closed system." Science must therefore suppose, in order to have a continued dynamism, that infinite recesses of space exist from which such influences come, since it denies creation. On the other hand, to have an eternally conserved universe it is necessary to have one which is in some sense finite, given once for all. But its finiteness must not be in the sense of a universe surrounded by immeasurable gulfs of emptiness for such a universe is already unhappily attenuated to zero or inexorably approaching such an extinction. To save the situation, there is required an image of the universe in which it will appear both finite and infinite.

It was the genious of Einstein that has made the last plausible attempt at such an accomplishment. Let us briefly state his hypothesis of "spherical space" which has been hailed everywhere as astounding both in its logical simplicity and consistency. We must not confuse his conception of a spherical universe with the ancient notion of a ponderous sphere beset with the fixed stars or the spherical universe of Copernicus. The universe is spherical to Einstein in the sense that straight lines do not exist, but when followed up will invariably return to their starting point. The universe is composed of the sum total of such lines of force, moving in immense circular paths of which the solar expeditions undertaken to verify Einstein's hypotheses have discovered objective evidence. The world is thus at once complete in itself but yet without boundaries. It is limited but it still constitutes the entire universe. In short, we have here a universe that is apparently at once finite and infinite; infinite in its dynamic aspects and finite in its amount; it is a universe with four dimensions.

Before criticising Einstein's solution, let us restate what we shall require of it. It must succeed where Newtonian physics has failed, and this failure was two-fold. It failed to show how mutually external forces can interact, and it failed to show how forces can be conserved.

Is the problem as to how *A* can impart its motion to *B* simplified if we suppose them to be moving in curvilinear fashion instead of in straight lines? There certainly will be no gain for this view if we conceive of circular motion as atomism conceives it. Atomism will either say (in the language of the calculus) that a circle is a succession of infinitely short lines constantly changing their direction, or that it is a row of points behaving in the same way. Since lines cannot be infinitely short we must conclude that at the instant of impact between *A* and *B* they are moving in rectilinear fashion and in this case we meet with all the objections confronted in Newton's view. Since points cannot be conceived as real without possessing diameters, they are equally inadequate. Einstein's universe, therefore is constituted of an infinite number of circles as mutually external to each other as the points in the Newtonian scheme. In both systems, each circle or point is a universe by itself without any relation to the others except it be in the mind of some onlooker.

In the last statement we have the answer also to the question as whether Einstein's universe is a conserved one. It may be said of both the points in Newton's system and the geodetic lines of relativism that neither are conserved since their conservation depends on a relation, and unless that relation is itself a generative one it must be a relation that is *understood* by an onlooker. *Thus the universe to be preserved must first be preserved in time; it must have a duration of its own.* If we set aside the logical difficulty of interaction in Einstein's universe, and allow the curvilinear forces therein to interact they will at once become involved in an interpenetration during which every force will modify every other and will itself be modified by all just as a falling pebble in Newton's system will jar the entire universe and will express in its reaction the momentum that the universe possesses. In Einstein's scheme, the total effect would be as that of a sphere which rotates at once in every conceivable direction, an impossible image!

Such a universe would be essentially a living one, before which all images fail. If the number of his forces were finite they would end eventually in a completely homogenous stability; and would be none other than Newton's absolute space, in short, would be non-existence. Einstein only saves the continuation of his scheme by supposing the number of his forces as infinite in number: for Newton's infinite space he substitutes infinite relations. And just as Newton's infinite space can be rendered intelligible only by Aristotle's view that it is pure possibility, a potter's clay for the creative spirit, so in Einstein's view the infinite relations are saved only by an onlooker who preserves them by remembering them. Aristotle held that matter arises when spirit impresses pure possibility with form, and Einstein's view will be inconsistent unless it holds that matter arises not when a relation is *seen* but when a relation is *achieved.* We are here in a position to see what space really signifies. It is because the spirit continually renews its achieving that old tasks are conceptualized as the points of an imaginary space stretched beneath them. To the spirit every form it discerns is an instrument of its freedom; and the ideal of life were to make of the entire universe a simple lever that will yield too rather than intercept the will. Every form is a worth only because it enhances life; and for it to become of greater worth it must enter with other forms into a higher construction, a more specialized instrument of freedom. This means that in order to become a higher form any given form must for the sake of calculation become a pure possibility else calculation will be crippled by being limited. Hence it must become a point in an ideal space retaining of its former character only its quantitative aspect. In the idea of space is at once the idea of utter barrenness and of infinite possibility, and of these simple experience gives us no wisdom. It is matter alone, embodying at once a promise and an achievement that is thus able to mirror the moral discovered in daily life that though life is irreversible, the choice of it is reversible. Space, therefore, is time stratified. *It is a momentary laying side by side of the many victories of life so that a major achievement may be projected from them.* It is the function of perception to cut the surrounding world into unit objects, each of which have been partly but not wholly subjected to the human will. The properties of space which they possess express the extent of their submission; and were they purely spacial they would indeed be no more than ideal, and the universe would spring miraculously into existence at the behests of thought: it would be a universe completely conquered, completely passive: it would be the pure space, the pure possibility of Aristotle. But *real* objects possess other properties than that of pure space—the property of resistance. As we have seen, resistance cannot obtain without time in which it occurs. *It is in this direction that interactions may be solved—by seeking to understand the very experience in which they occur, the experience of strife.* It is in this way that the inert must be explained by the living, and not the living by the inert. Relativism may mark another mile-stone in physics apparently because it has saved the principle of conservation. But what is the inner meaning of this achievement? It is, that relativism marks an epoch in the history of science because it saves the creative power of science by thus saving the possibility of prediction. That is, relativism is destined to be a tool in the hands of a creative force in the universe it so expressly denies. Nay, relativism was itself born of the creative imagination of man.

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